International Journal on Emerging Technologies (Special Issue NCETST-2017) **8**(1): 678-682(2017)
(Published by Research Trend, Website: www.researchtrend.net*)*

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

Systematic Review on Routing Protocols for Vehicular Ad Hoc Networks: A Survey and Future Perspectives

Priyanka Agrawal[1], Amit Joshi[1] and Rahul Palaria[2]

[1]M. Tech Scholar, Department of CSE, G. B. Pant University of Agriculture and Technology,
[2]Assistant Professor, Department of CSE, Amrapali Group of Institutes (U.K.), INDIA

ABSTRACT: Vehicular ad hoc network, a subclass of MANET, is a technology that enables deployment of intelligent transportation system. In VANET each vehicle is equipped with various wireless transmission capabilities like GPS and Bluetooth through which these vehicles connect with each other. In this paper we have surveyed various routing protocols that have been developed to improve the efficiency of ITS. This paper includes both the topology based and position based protocols.

I. INTRODUCTION

Vehicular ad hoc network (VANET) is an emerging technology that enables vehicles to communicate with each other for information such as traffic and route which in turns enables smooth transition of traffic on roads. It uses advanced wireless technology in the field of wireless communication to provide an intelligent transportation system. VANET is one of the most emerging research fields for researchers due to its highly dynamic topology and link disorder problem. Vehicles equipped with the microelectronics and wireless communication technologies they are becoming intellectual electronics equipments, and are known as wireless On Board Units (OBUs), often called as "computers on wheels [1]." Along with the addition of advanced processers, GPS, storage space, and sensors, OBUs provide ad hoc network connectivity. Vehicles can be in touch with each other and with fixed roadside units while travelling on roads.
These fixed roadside infrastructures, described as roadside units (RSUs).
The rest of the paper is organized as follows: section II states classification of routing protocols, sections III, IV, and V describes proactive routing protocols, reactive routing protocols and hybrid protocols respectively. Section VI shows thee routing protocols based on evaluation metric.

II. CLASSIFICATION OF ROUTING PROTOCOLS

An ad hoc network desires a routing protocol that permits data packets to be circulated from one vehicle to other vehicle. Usually, the routing protocol in ad hoc network is divided into three major classes: first is proactive, second one is reactive (on-demand) and hybrid protocols. Figure 2.1 depicts the taxonomy of routing protocols in VANET.

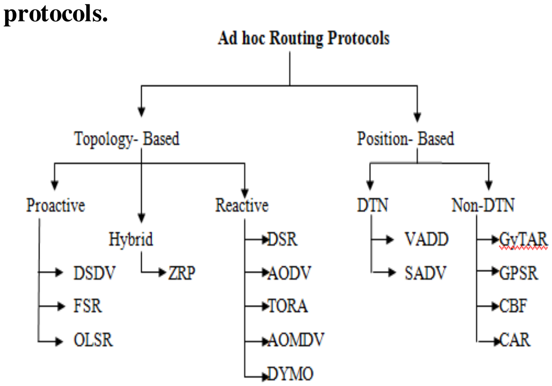

Fig. 1. Taxonomy of routing protocols in VANET.

III. PROACTIVE ROUTING PROTOCOLS

Proactive routing protocols are commonly termed as table driven routing protocol. In this each node contains a routing table that consists of information to all other node in the network. Because of the mobility of the nodes, they keep on changing their location, the routing tables maintained by unlike nodes are periodic or whenever a change happens they are restructured. The proactive routing protocols differ in various areas like how the changes are propagated in the network. The examples of proactive routing protocols are discussed in details in the following paragraphs.

Perkins *et al*. (1994) proposed Destination Sequenced Distance vector routing protocol [2]. In DSDV, nodes transmit updates at regular intervals to its neighbour nodes with the data of its own routing table. This protocol makes the use of tables for ad hoc mobile network and related to Bellmen Ford algorithm. It maintains a routing table that store cost metric for routing path, the destination sequence number assigned by the destination node and tackle of the next node selection till the destination. In DSDV, a new sequence number is essential when the topology of the network changes before the node altered the information in the routing table and send updates to its neighbour.

Gerla *et al*. (2000), proposed a Fisheye State Routing Protocol [3], a routing scenario for Ad Hoc networks. FSR is a table driven routing protocol where the information of each vehicle is collected from the neighbouring vehicle. This protocol is basically improvement to the Link State Routing and Global State Routing. It works as an proficient link State routing that upholds a topology map at every node and propagate the state of links update with immediate neighbor only and not on the overall network. The information of the link state is broadcasted in diverse frequencies for dissimilar entries depending on their hop distance from the recent node.

Jacque *et al*. (2003) proposed Optimized Link State Routing (OLSR) [4] proactive routing protocol for wireless ad hoc network. It is an optimization of a pure link state protocol for mobile ad hoc networks. In OLSR, three levels of optimization are achieved. First, few nodes are selected as Multipoint Relays (MPRs) to broadcast the messages during the flooding process. This is in contrast to what is done in classical flooding mechanism, where every node broadcasts the messages and generates too much overhead traffic. A set of neighbour nodes are selected by each node in the network, known as multipoint relays (MPR) that further transmits the packets. The packets are only read and process by the neighbour nodes that are not available in its MPR set. This method in turn lowers the number of transmissions in a broadcast procedure.

IV. REACTIVE ROUTING PROTOCOL

Reactive routing protocols are also called as the on-demand routing protocols. In reactive protocols route framing occurs only when the communication is required from the source node to the destination node and no set of previously determined routes exist in the network. The source node will begin a route finding procedure when there is no route from the source to the destination but a source node desires to send a packet to a destination node, to construct a communication route. Later when the route is settled, a preservation process will take place for route maintenance until the link breaks. This in turn diminishes the traffic in the network and saves bandwidth. On demand routing protocols are appropriate for huge ad-hoc networks which are extremely portable, movable and have dynamic topology.

The following paragraphs demonstrate some of the reactive routing protocols.

Johnson *et al*. (1996) proposed a Dynamic Source Routing protocol [5] for ad hoc networks. This protocol is based on the source routing, i.e. when any node requires a route to other node, it vigorously find one based on cashed information and on the result of route discovery protocol. The two phases of this protocol is Route discovery and maintenance. Whenever the node needs to send a message it verify its route cache for an unexpired route to the destination, if it found one it starts transmission of packet else starts searching for a new route in between source to destination. Each route request packet has a source node address, a new sequence number and the destination node's ID. The DSR protocol was able to quickly adapt the changes such as host movement in wireless ad hoc networks, and requires no routing overheads over the periods when such changes do not occur.

Perkins *et al*. (1999) proposed Ad hoc On Demand Distance vector routing (AODV) [6], for the operation of ad hoc networks. AODV is quite suitable for a dynamic self starting network as it provides loop free routes even while repairing broken links. AODV combines the destination sequence number in DSDV with on demand route discovery technique in DSR. AODV is based on hop by hop routing approach. The source node initiates a route request packet to its neighbors for searching route from source node to destination node and the procedure it repeated until the path to the destination node is obtained. This process also checks the sequence number at each in-between node to create a loop free path. If a node gets the sequence number in its routing table then the node reject the route request packet or else stores the number in its routing table. The reverse path of the route request packet is followed by the route reply packet therefore the AODV protocol makes the use of only symmetric links between neighbouring nodes.

Marina *et al*. (2001) proposed On Demand Multipath Distance Vector Routing [7] for mobile Ad Hoc Networks. It is an extension to AODV, and the resulting protocol is referred to as AOMDV. The protocol computes multiple loop free ad link disjoint paths. Link-disjointness of multiple paths is achieved by using a particular property of flooding. It was designed for highly dynamic ad hoc networks where link failure occurs frequently. The key concept in AOMDV is computing multiple loop free paths per route discovery. Due to the availability of multiple redundant paths, the protocol switches to a different path when an earlier path fails. In AOMDV only link disjoint paths are computed so that the path fails independently of each other.

V. HYBRID ROUTING PROTOCOLS

The benefits of the proactive routing and the reactive routing are combined in hybrid routing protocol. Hybrid routing is also known as balanced-hybrid routing, incorporates link-state routing and distance-vector routing. Distance-vectors are being used in these protocols to find best paths to destination nodes, and retransmit routing data only when the network topology varies. To lower the control overhead of proactive routing protocols and lessens the initial route discovery delay in reactive routing protocols, hybrid protocols are being used. Thus it works better in highly dynamic topology such as VANET. A Hybrid routing protocol for Ad hoc networks, ZRP, is described below.

Haas *et al*. (2002) proposed a hybrid routing protocol named, the Zone Routing Protocol (ZRP) [8], which is designed by combining the best properties of both proactive routing protocol as well as reactive routing protocol. This protocol divides the whole network into zones. In a network, zone is a group of nodes which are in a radius. Zone radius size depend on its length α where α is the number of hops to the perimeter of the zone. In ZRP, for intra-zone communication, an IARP, stands for inner-zone reactive routing protocol and Intra-Zone routing protocol (IARP) is used. The main purpose of ZRP is to find loop free routes to the destination.

VI. ROUTING PROTOCOLS BASED ON METRIC EVALUATION

Füßler *et al.* (2004) proposed a Contention Based Forwarding (CBF) [9] for street scenarios in VANETs. The contention-based forwarding (CBF) algorithm is a greedy position-based forwarding algorithm that does not require the proactive transmission of beacon messages. Instead, data packets are broadcast to all direct neighbours and the neighbours themselves decide if they should forward the packet. When the neighbor receives the data packet, it determines a timeout based on the progress that the packet will make in relation to its destination if the neighbour retransmits it. In CBF, the next hop is selected through a distributed contention process based on the actual positions of all of the current neighbours. In this contention process, CBF makes use of biased timers. The actual forwarder is selected by a distributed timer-based contention process which allows the optimal node to forward the packet and to suppress other potential forwarder.

Nzouonta, *et al.* (2009) proposed a Road Based using Vehicular Traffic (RBVT) [10] routing for vehicular ad hoc networks. RBVT protocol makes the use of the real-time traffic information of vehicles to generate road-based paths contained of intersection at roads that have relatively large network connectivity among all. Geographical forwarding is used to transfer packets between intersections on the path, reducing the path's sensitivity to individual node movements. The vehicles are required to transmit several control packets to all the other vehicles in order to determine routing paths that are connected to each other, create routes and keep route information up to date. For dense networks, it advanced the forwarding using a distributed receiver-based election of next hops based on a multi criterion prioritization function that takes non uniform radio propagation into account. Here two protocols are designed by the author one is reactive routing protocol, RBVT-R, and the other one is proactive routing protocol, RBVT-P.

Jerbi, *et al*. (2009) proposed an Improved Greedy Traffic aware Routing (GyTAR) [11] protocol for vehicular scenarios. In this the road segments are divided into different cells and a leader vehicle. It consists of two modules first one is the selection of junction and second one is the data transmission between two junctions. Every data packet needs to bypass the junction in order to reach its destination node. At every junction selection method is applied and at each junction a value is assigned by analyzing the traffic density between the current junction and the next candidate junction and the curve metric distance to the destination and finally the junction with maximum value will be selected for data packet transmission. In other module a table is maintained in every vehicle which comprises of velocity, position and direction of every neighbour vehicle and periodical updating of table is needed. Thus, upon receiving the data packet, the transmitting node evaluates the new forecasted position of each neighbour through the table and then the next hop is selected which pretends to be nearer to the destination junction that may cause packets to be at most favorable node.

Ding, *et al*. (2010) proposed a Static Node Assisted Adaptive Routing Protocol (SADV) [12] in VANETs. In SADV fixed station called static nodes are distributed by scenario, located at intersections points. When there exist no vehicles to distribute the data packets along the most favorable path then the packet is transmitted to the static node. This node is capable to feed the packet and retransmit it when the best possible route becomes available. Adding to this, these fixed stations are responsible for calculating the average delay of forwarding data between each. SADV also dynamically adapts to varying traffic density by allowing each node to measure the amount of time for message delivery. SADV assumes that each vehicle has accessed to external static street map and knows its position through GPS. SADV's operation takes place in two modes: "In Road Mode" and "Intersection Mode".

Ding, *et al*. (2011) proposed an Improved AODV Routing protocol for VANETs [13]. In this improved AODV routing protocol in VANET, two steps optimization is done in route discovery and route selection process to decrease overhead and improve the route stability. For development the information of speed and direction of vehicle are included. In the first phase, the nodes with the stable links are chosen to forward route request packet. Along with that the control overhead is lowered due to the fact that some of the nodes are idle and are not used to forward route request. In the other phase, the route with the highest stability will be used for data forwarding when the source vehicle obtains various paths to destination vehicle. By the two phase optimization, the route selected for transmitting packets is more stable and overhead is decreased.

Tu, Hongyu *et al*. (2014) proposed an improved routing protocol using traditional GPSR protocol that is named as GPSR-MV [14]. It is a routing protocol based on moment of vehicles for VANET. Fast moving and forwarding efficiency of vehicles has been used in GPSR-MV. According to the GPS installed in vehicles the position information such as, the velocity of the neighbouring nodes will be evaluated in GPSR-MV, and the information of position will be updated accordingly. It takes that source node is always horizontal to the destination node and divide the movement of vehicles into two directions one is vertical and the other is horizontal. It then selects the next hop which is furthest to the source node. If the node a's position is (x_1, y_1) at time step t_1, while its position is (x_2, y_2) at time step t_2. t_1 and t_2 are the time when the GPS updates information. GPSR-MV takes the node's position in consideration, to predict the nodes' position before data transmission.

The values that can be used to calculate the speed of node a, are as follows.

$$V_a = \frac{\sqrt{(y_1 - y_2)^2 + (x_2 - x_1)^2}}{t_1 - t_2}$$

And the movement direction is:

$$\theta_a = \tan^{-1} \frac{y_2 - y_1}{x_2 - x_1}$$

Soares *et al*. (2014) proposed An Adaptive Data Dissemination protocol With Dynamic Next Hop Selection for Vehicular Networks[15]. It aims to build up a protocol that is simply adjustable to most changing topology scenarios of vehicles, hence designed TODD, an adaptive Traffic-Oriented Data Dissemination protocol. TODD uses real time traffic knowledge to vigorously select the top next vehicles. The process is initiated by evaluating a formula calculated for each participating vehicle, which give inclination to particular vehicle components such as speed, distance to the destination, and traffic density based on the ongoing traffic knowledge. The main contribution of TODD is the Dynamic Next Hop selection technique, which takes in to account the advanced behavior of different traffic scenarios. TODD does not evaluate dissemination routes before sending data packets. In its place, roads are chosen at every intersection through which packets should be sent, in accordance with the traffic scenario at every road. To eliminate broadcast storms problem, TODD also allows a vehicle to vehicle communication along the vehicles on the roads, in order to choose next node for data packets exchange of RTS and CTS packets also takes place. The carry-and-forward mechanism is needed to tackle the fragmentation problems. Besides that, this paper also proposed a centralized version of TODD (CTODD).CTODD deals with the deficiency of real-time vehicular information that is stored in the vehicles. For dense and sparse scenarios a study was performed to evaluate the best coefficients.

Equation defines the metric calculation used in this work.

$$f(\alpha,\beta,\gamma) = \theta * (1 - \alpha/\alpha_{\max}) + \lambda(\beta/\beta_{\max}) + \mu(\gamma/\gamma_{\max})$$

Shen *et al.* (2014) proposed a new routing protocol AODV with Predicting Node Trend (AODV-PNT) [16] that is suitable VANET communication. There are two main enhancement in AODV-PNT, the first one is it evaluates the routing metric improvements of the vehicles and calculate the total weight of the route (TWR). The movement information of the Vehicle including speed, acceleration, direction and link quality is being used as routing metric and on this basis TWR is calculated. The other one is that it predicts node's future TWR and calculate fixed threshold W in an attempt to choose suitable relay node. In short, this paper improves the link quality in between the vehicles. Finally the simulation is done using NS-2, the simulation results shows that AODV-PNT achieves better results than AODV in terms of PDR, average end to end delay and routing overhead.

The TWR to the source node to the next-hop node could be expressed in the following mathematical equation:

$$TWR = f_s * |S_n - S_d| + f_a * |\theta_n - \theta_d| + f_q * Q$$

VII. CONCLUSION

Various Routing Protocols have been discussed for Vehicular Ad hoc Networks. Since Vehicular Ad hoc Networks is a life Critical Technology, this field requires attention from all stakeholders i.e Automobile Companies, Computer Science Engineers. Thus, Vehicular Ad hoc Networks has emerged as a promising technology of the future.

REFERENCES

[1] Imrich Chlamtac A.; Marco Conti B.; Jennifer J. and Liu C. 2003. Abstract Mobile Ad-hoc Networking: Imperatives and Challenges. *Ad-hoc Networks Journal*, 1(1): 13-46.

[2] Perkins, E. C. and Bhagwat, P. 1994. Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers. ACM. pp.234 – 244.

[3] Pei, G.; Gerla, M. and Chen, T. W. 2000. Fisheye State Routing: A Routing Scheme for Ad Hoc Wireless Networks. Communications, 2000. ICC 2000. IEEE International Conference. 1: 70-74.

[4] Jacquet, T. and Clausen, P. 2003. Optimized Link State Routing Protocol (OLSR). In: IETF RFC 3626 Network Working Group. pp. 1-7

[5] Johnson, D.B. and Maltz, D.A. 1996. Dynamic Source Routing in Ad Hoc Networks. Mobile Computing, Kluwer Academic. 353: 152-181.

[6] Perkins, E. C. and Royer, E. M. 1999. Ad-Hoc On Demand Distance Vector Routing. In: Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications (WMCSA). pp. 90-100.

[7] Marina, M. and Das, S. 2001. On-demand multipath distance vector routing in ad hoc networks. In: Proceedings of the International Conference on Network Protocols (ICNP), IEEE. pp 14-23.

[8] Hass, J. Zygmunt; Pearlman, R. Marc and Samar, Prince. 2002. The Zone Routing Protocol (ZRP) for Ad Hoc Networks.

Internet-Draft, http://tools.ietf.org/id/ draft-ietf-manet-zone-zrp-04.txt.

[9] F¨ußler, H.; Hartenstein, H.; Mauve, M.; Effelsberg, W. and Widmer, J. 2004. Contention-Based Forwarding for Street Scenarios. 1st International Workshop in Intelligent Transportation (WIT).

[10] Nzouonta, J.; Rajgure, N.; Wang, G. and Borcea, C. 2009. VANET routing on city roads using real-time vehicular traffic information. IEEE Transactions on Vehicular Technology. 58(7): 3609-3626.

[11] Jerbi, M.; Senouci, M. S.; Rasheed, T. and Ghamri-Doudane, Y. 2009. Towards efficient geographic routing in urban vehicular networks. Vehicular Technology, IEEE Transactions on. 58(9): 5048–5059.

[12] Ding, Y. and Xiao, L. 2010. Sadv: Static-node-assisted adaptive data dissemination in vehicular networks. Vehicular Technology, IEEE Transactions. 59(5): 2445–2455.

[13] Ding, B.; Chen, Z.; Wang, Y. and Yu, H. 2011. An Improved AODV Routing Protocol for VANETs. IEEE. In: international conference on wireless communication and signal processing. pp. 1-5.

[14] Tu, Hongyu; Peng, Lei; Li, Huiyun and Liu, Falin. 2014. GSPR-MV:A Routing Protocol Based on Motion Vector for VANET. In: 12th International Conference on Signal Processing (ICSP). IEEE. pp. 2354-2359.

[15] Soares, B. Rodrigo; Tostes, J. I. A.; Nakamura, Eduardo, F. and Loureiro, F. A. Antonio 2014. An Adaptive Data Dissemination Protocol with Dynamic Next Hop Selection for Vehicular Networks. Computers and Communication (ISCC), IEEE Symposium. pp 1-7.

[16] Shen, Xiaowei; Wu, Yi; Xu, Zhexin and Lin Xiao. 2014. AODV- PNT : An Improved Version of AODV Routing Protocol with Predicting Node Trend in VANET. In: 2014 IEEE 7th International Conference on Advance Infocomm Technology (ICAIT). IEEE. pp. 91-97.